

CHAPTER 3 Agents of Erosion and Deposition

SECTION 1 **Shoreline Erosion and Deposition**

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- What is a shoreline?
- How do waves shape shorelines?

National Science Education Standards
ES 1c

How Do Waves Form?

Waves form when wind blows over the surface of the ocean. Strong winds produce large waves. The waves move toward land. When waves crash into the land over a long time, they can break rock down into smaller pieces. These pieces are called *sand*.

A **shoreline** is a place where the land and the water meet. Most shorelines contain sand. The motion of waves helps to shape shorelines. During *erosion*, waves remove sand from shorelines. During *deposition*, waves add sand to shorelines. ✓

STUDY TIP

Summarize Read this section quietly to yourself. Talk about what you learned with a partner. Together, try to figure out the answers to any questions that you have.

WAVE TRAINS

Waves move in groups called *wave trains*. The waves in a wave train are separated by a period of time called the *wave period*. You can measure the wave period by counting the seconds between waves breaking on the shore. Most wave periods are 10 to 20 s long.

When a wave reaches shallow water, the bottom of the wave drags against the sea floor. As the water gets shallower, the wave gets taller. Soon, it can't support itself. The bottom slows down. The top of the wave begins to curl, fall over, and break. Breaking waves are called *surf*.

READING CHECK

1. Compare How is wave erosion different from wave deposition?



Waves travel in groups called wave trains. The time between one wave and the next is the wave period.

Math Focus

2. Calculate A certain wave train contains 6 waves. The time between the first wave and the last wave is 72 seconds. What is the wave period?

SECTION 1 Shoreline Erosion and Deposition *continued*

POUNDING SURF

The energy in waves is constantly breaking rock into smaller and smaller pieces. Crashing waves can break solid rock and throw the pieces back toward the shore. Breaking waves can enter cracks in the rock and break off large boulders. Waves also pick up fine grains of sand. The loose sand wears down other rocks on the shore through abrasion. ✓

✓ READING CHECK

3. Identify Give two ways that waves can break rock into smaller pieces.

Critical Thinking

4. Identify Relationships When may a storm not produce high-energy waves?

TAKE A LOOK

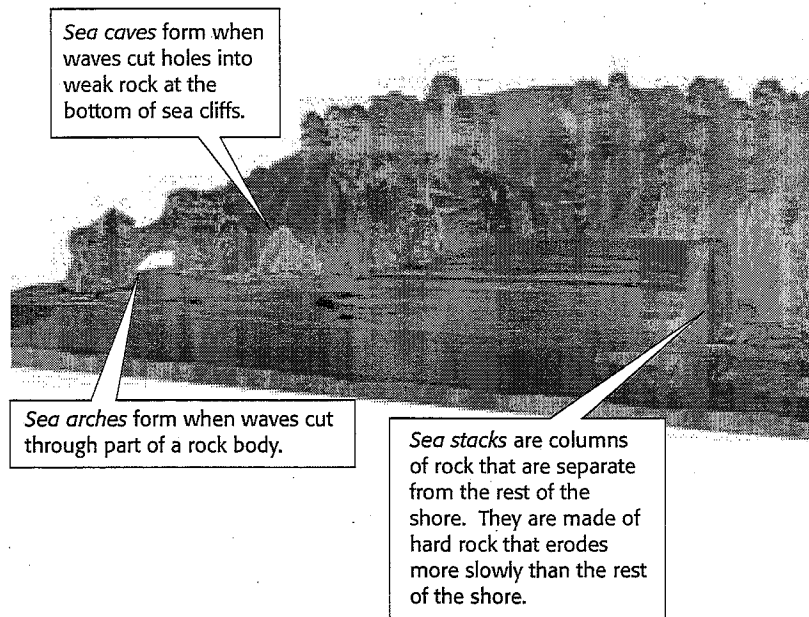
5. Compare How is a sea stack different from a sea arch?

What Are the Effects of Wave Erosion?

Wave erosion can produce many features along a shoreline. For example, *sea cliffs* form when waves erode rock to form steep slopes. As waves strike the bottom of the cliffs, the waves wear away soil and rock and make the cliffs steeper.

How fast sea cliffs erode depends on how hard the rock is and how strong the waves are. Cliffs made of hard rock, such as granite, erode slowly. Cliffs made of soft rock, such as shale, erode more quickly.

During storms, large, high-energy waves can erode the shore very quickly. These waves can break off large chunks of rock. Many of the features of shorelines are shaped by storm waves. The figures below and on the next page show some features that form because of wave erosion.

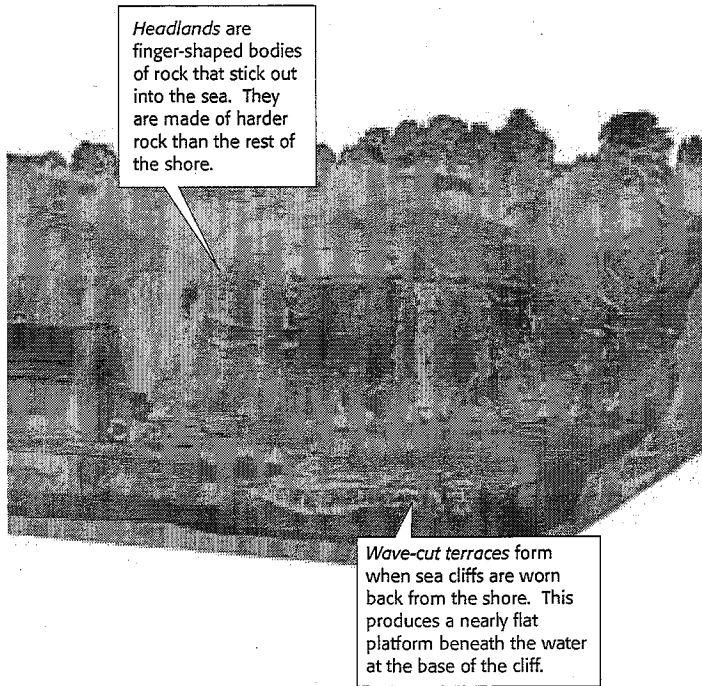


Sea caves form when waves cut holes into weak rock at the bottom of sea cliffs.

Sea arches form when waves cut through part of a rock body.

Sea stacks are columns of rock that are separate from the rest of the shore. They are made of hard rock that erodes more slowly than the rest of the shore.

SECTION 1 Shoreline Erosion and Deposition *continued*



Headlands are finger-shaped bodies of rock that stick out into the sea. They are made of harder rock than the rest of the shore.

Wave-cut terraces form when sea cliffs are worn back from the shore. This produces a nearly flat platform beneath the water at the base of the cliff.

STANDARDS CHECK

ES 1c Land forms are the result of a combination of constructive and destructive forces. Constructive forces include crustal deformation, volcanic eruption, and deposition of sediment, while destructive forces include weathering and erosion.

6. Define What is a headland?

What Are the Effects of Wave Deposition?

Waves carry many materials, such as sand, shells, and small rocks. When the waves deposit these materials on the shoreline, a beach forms. A **beach** is any area of shoreline that is made of material deposited by waves. Some beach material is deposited by rivers and moves down the shoreline by the action of waves. ✓

Many people think that all beaches are made of sand. However, beaches may be made of many materials, not just sand. The size and shape of beach material depend on how far the material traveled before it was deposited. They also depend on how the material is eroded. For example, beaches in stormy areas may be made of large rocks because smaller particles are removed by the waves.

The color of a beach can vary, too. A beach's color depends on what particles make up the beach. Light-colored sand is the most common beach material. Most light-colored sand is made of the mineral quartz. Many Florida beaches are made of quartz sand. On many tropical beaches, the sand is white. It is made of finely ground white coral. ✓

Beaches can also be black or dark-colored. Black-sand beaches are found in Hawaii. Their sands are made of eroded lava from volcanoes. This lava is rich in dark-colored minerals, so the sand is also dark-colored. The figures on the next page show some examples of beaches.

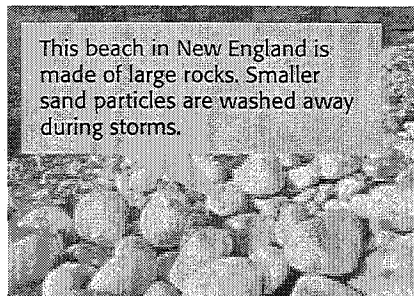
✓ **READING CHECK**

7. Define Write your own definition for *beach*.

✓ **READING CHECK**

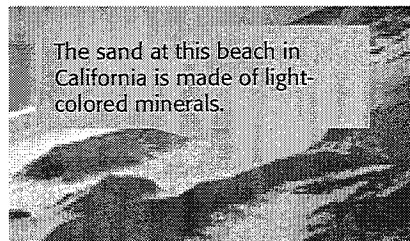
8. Identify What mineral is most light-colored sand made of?

SECTION 1 Shoreline Erosion and Deposition *continued*



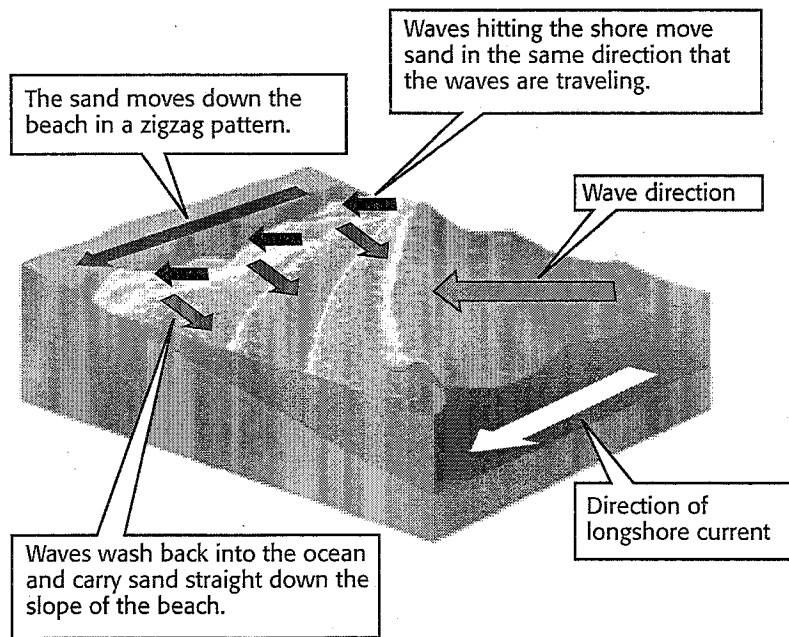
TAKE A LOOK

9. Explain Why are some beaches made mostly of larger rock pieces, instead of sand?



WAVE ANGLE AND SAND MOVEMENT

Waves can move sand along a beach. The movement of the sand depends on the angle at which the waves hit the shore. *Longshore currents* form when waves hit the shore at an angle. The waves wash sand onto the shore at the same angle that the waves are moving. However, when the waves wash back into the ocean, they move sand directly down the slope of the beach. This causes the sand to move in a zigzag pattern, as shown in the figure below.



TAKE A LOOK

10. Infer Why don't longshore currents form in places where waves hit the shore head-on?

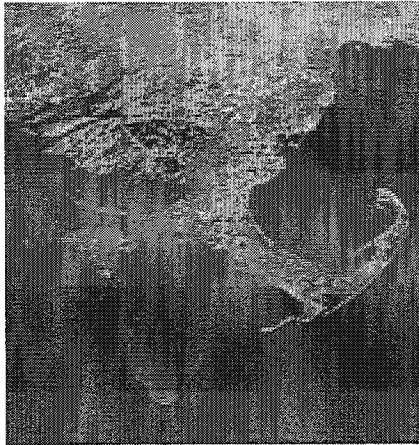
SECTION 1 Shoreline Erosion and Deposition *continued*

OFFSHORE DEPOSITS

Longshore currents can carry beach material offshore. This process can produce landforms in open water. These landforms include sandbars, barrier spits, and barrier islands.

A *sandbar* is a ridge of sand, gravel, or broken shells that is found in open water. Sandbars may be completely under water or they may stick up above the water. ✓

A *barrier spit* is a sandbar that sticks up above the water and is connected to the shoreline. Cape Cod, Massachusetts, is an example of a barrier spit. It is shown in the figure below.



Cape Cod, Massachusetts, is an example of a barrier spit. Barrier spits form when sandbars are connected to the shoreline.

A *barrier island* is a long, narrow island that forms parallel to the shoreline. Most barrier islands are made of sand.



Santa Rosa Island in Florida is an example of a barrier island.

READING CHECK

11. Define What is a sandbar?

TAKE A LOOK

12. Identify What is a barrier spit?

TAKE A LOOK

13. Compare What is the difference between a barrier island and a barrier spit?

Section 1 Review

NSES ES 1c

SECTION VOCABULARY

beach an area of the shoreline that is made up of deposited sediment

shoreline the boundary between land and a body of water

1. **Compare** How is a shoreline different from a beach?

2. **Explain** Where does the energy to change the shoreline come from? Explain your answer.

3. **Identify** Give two examples of different-colored beach sand and explain why each kind is a certain color.

4. **Explain** How do longshore currents move sand?

5. **List** Give five landforms that are produced by wave erosion.
